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Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. 09/766,069 | Applicant(s) KAHN ET AL. | |
|---|---|---|---|
| | Examiner Julian A. Mercado | Art Unit 1745 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) 1-17 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) 1-17 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 4-13 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 4 recites the limitation "sufficient strength and thickness" in line 3. It is unclear what comprises a "sufficient" level of strength for the magnetic field. Additionally, it is unclear as to how the magnetic field "thickness" may be measured since magnetic field lines extend infinitely into space.

Claim 5 in line 13 recites a similar limitation to claim 4 above and is rejected under the same grounds.

Claim 8 recites the limitation "the perimeter" in line 3. There is insufficient antecedent basis for this limitation in the claim.

Claim 8 recites the limitation "the area" in line 4. There is insufficient antecedent basis for this limitation in the claim.

Claim 16 recites the limitation "to assure unstable operation of said electron beam" in lines 19-20. This limitation is unclear as it appears to recite an adverse, undesirable condition.

Claims 6-13 are rejected under 35 U.S.C. 112, second paragraph as being dependent upon a rejected base claim.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 9 and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. (U.S. Pat. 4,376,688) in view of Fu et al. (U.S. Pat. 5,914,018) and as evidenced by King (U.S. Pat. 4,108,751)

Regarding claim 1 and method claims 14-16, Ceasar teaches a sputtering apparatus for use in an evacuated volume such as in a vacuum chamber [10]. (Figure 1)

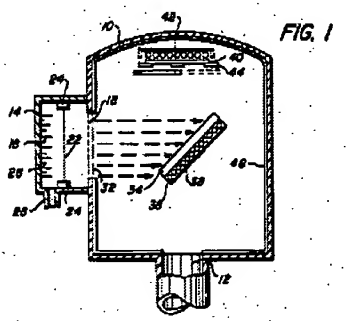

FIG. 1

The apparatus comprises an ion source means [14] with means for introducing an ionizable gas [28] for producing a plasma. (col. 5 line 60-62)

producing a very uniform beam. The reactive gas which may be a mixture of hydrogen and argon is introduced into the ion gun from the gas inlet 28. In front of

A sputter target [34] is disposed in the ion efflux of the ion source means and enclosed by an enclosure [36], wherein the ion efflux as shown by the arrows originating from the ion source are directed towards the target. A deposition substrate [40] is positioned opposing to the target so that the sputtered material from the target is deposited onto its surface. (col. 6 line 47-51)

When the ion beam strikes the target, the target is sputtered, and the sputtered target material is sprayed around the vacuum chamber with a large amount of the sputtered target coming to rest as a thin film on the substrate, which may be at ambient temperature or

The pressure of the ionizable gas within the evacuated volume, the first pressure, is substantially less than the pressure of the gas within the ion source means, the second pressure. As an example, the pressure of the ionizable gas within the evacuated volume is equal to $5 \times 10^{-9}$ to about $10^{-3}$ torr, while the pressure of the gas within the ion source is equal to $10^{-3}$ to $10^{-2}$ torr. (col. 5 line 38-46)

ence to the apparatus that can be used to perform it. The stainless steel vacuum chamber 10 is evacuated through conduit 12 by a pump (not shown) to provide a pressure in the chamber of from about $5 \times 10^{-9}$ Torr to about $10^{-3}$ Torr. The ion beam generating device or gun 14 which is a Kaufmann type ion source is attached to the vacuum chamber on a port flange and when the chamber is evacuated the pressure in the ion gun with gas flowing through it is from about $10^{-3}$ to $10^{-2}$ Torr. The

Thus, the vacuum in the evacuated volume is 1 to 2 orders of magnitude higher than the vacuum in the ion source means. (col. 6 line 34-37) This vacuum pressure corresponds to a pressure 1 to 2 orders of magnitude less than the pressure within the ion source means. (applies to claim 1)

As to an additional reactive gas, Ceasar teaches an additional gas in the form of a reactive gas [11] is introduced into the ion source means. (col. 5 line 60-62, applies to claim 9)

producing a very uniform beam. The reactive gas 60 which may be a mixture of hydrogen and argon is introduced into the ion gun from the gas inlet 28. In front of

This gas is reacted during sputtering with the target material while the target material is positioned in the evacuated volume, thus, the reactive gas is ultimately introduced into the reacted volume. (col. 6 line 62-64)

The reactive gas introduced to the ion gun contains at least one gas which will be reactive during sputtering with the target material. Typical reactive gases include

Therefore, the reactive gas is ultimately introduced into the evacuated volume. Because of this reaction, the reactive gas is also considered to promote the formation of compounds incorporating both the reactive gas and the material sputtered from the target.

As to an energy of about 50 eV or less, Ceasar teaches that control of the ion beam energy is achieved by varying the bias voltage between 0 to about 2000 eV. (Col. 4 lines 27-29) Absent of unexpected results, it is asserted that the energy level of the ion source is an optimizable parameter for a result-effective variable. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980) As evidence, King is relied upon to show that 20-30 eV is the threshold for the onset of sputtering to occur, thus, any energies of higher value would naturally result in a correlative increase in sputtering. (col. 4 line 58-66, applies to claim 1, 16)

material (ten's of Angstrom's or more). The threshold energies for sputtering for most combinations of incoming ion and substrate material are in the 20–30 eV range, but removal of significant amount of surface material (i.e. yields approaching 1 atom/ion) are not usually achieved until incoming energies are in the order of 100's of eV's. Penetrations in the order of 10's to 100's of Angstroms by the oncoming ions are achieved with incoming ion energies in the 1–5 keV range. Higher

Ceasar does not explicitly teach a negatively biased target relative to ground. However, Fu teaches negative biasing of a target relative to a grounded enclosure wall. (col. 1 line 33-36, applies to claim 1, 15)

> the target **18** and enclosure wall **12**. The enclosure wall **12** is preferably grounded, so that a negative voltage may be maintained on the target **18** with respect to the grounded enclosure wall **12**. A shield **26** may be suspended within the

Thus, at the time the invention was made, it would have been obvious to one skilled in the art to modify Ceasar's invention by biasing the target negative to ground for reasons such as providing sufficient energy difference between the ion source means and the target and to facilitate target ablation.

Ceasar does not explicitly teach a curved target surface wherein the target surface is concave (claim 2) or convex (claim 3). However, Fu teaches a curved target surface having a concave surface [106] as well as a convex surface [104]. (Figure 5D, col. 4 line 35-49)


*Fig. 5D*

> As shown in FIG. 5(*b*), the target **80** has a sidewall may have more than one sloped portion **82,84**, so long as the plasma will sputter all the surfaces. Therefore, both of the individually sloped portions **82,84** should have a slope $\alpha_1$, and $\alpha_2$, respectively, between about 15 and about 60 degrees, with the preferred slopes being between about 20 and about 45 degrees. Furthermore, as shown in FIG. 5(*c*), the target **90** may have a curved sidewall **92** so long as the plasma will sputter the entire surface. Generally, this will require that lines **92** tangent to the curve **92** have an angle $\alpha_{max}$ within the ranges just defined for sloped portions. Further still, the target **100** shown in FIG. 5(*d*) has a sidewall **102** having gentle transition or curved surface **104** between the central region **106** and the sidewall **102**. FIG. 5(*d*) also shows a central target region **106** that is contoured.

Thus, at the time the invention was made, the skilled artisan would have found obvious to modify Ceasar's invention by employing a concave or convex target surface. The motivation for such a modification would to be to uniformize plasma sputtering thereon.

Claims 4, 5 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. in view of Fu et al. and as evidenced by King as applied to claims 1-3, 9 and 14-16 above, and further in view of Pinarbasi (U.S. Pat. 5,492,605)

The teachings of Ceasar, Fu and King are discussed above.

Ceasar does not explicitly teach a magnetic field located near the sputter target having sufficient energy to contain secondary electrons generated by the ion efflux. However, Pinarbasi teaches a magnetic field to prevent electrons from traveling directly to the anode, resulting in an increase in ionization efficiency and beam uniformity at the target. (col. 5 line 15-19)

> shown). A magnetic field may also be used to prevent the electrons from traveling directly to the anode thereby increasing ionization efficiency and to increase beam uniformity. Aligned with and positioned closely adjacent to the

Thus, the skilled artisan would have found obvious to employ a magnetic field near the sputter target for reasons such as enhanced ion beam collation thereto.

Claims 6, 7 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar in view of Fu et al. and as evidenced by King as applied to claims 1-3, 9 and 14-16 above, and further in view of Quazi (U.S. Pat. 4,693,805).

The teachings of Ceasar, Fu and King are discussed above.

Ceasar does not explicitly teach a radiofrequency bias for the sputter target and in which the negative bias is a mean value of the radiofrequency bias. However, Quazi teaches a radiofrequency bias to a target which is a negative bias based on a mean value of the radiofrequency bias. (col. 5 lines 36-38)

> The generator in the present invention typically produces a 13.56 MHz output and its waveform may have the shape as shown in FIG. 4A. The duty cycle of the

The net bias to the target is a negative bias. (col. 1 lines 57-60)

> Although an RF glow discharge is initially produced by using a symmetrical sinusoidal output of the RF generator, in an assymmetrical sputtering system there appears a negative self-bias at the target. This can be 60

The target is made positive during the positive cycle of the RF bias for only a brief period of time sufficient to remove charge build-up on the target. (Col. 5 lines 56-62) Thus, a mean value of the radiofrequency bias to the target is negative. As an example, the duty cycle during which the target is pulsed negative is typically 60-90 percent while the remaining 40-10 percent comprises the positive duty cycle. (col. 7 lines 24-28, applies to claim 6, 7, 13) The motivation for such a modification would be to increase the sputtering rate and utilized power.

Claims 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar in view of Fu et al. and as evidenced by King as applied to claims 1-3, 9 and 14-16 above, and further in view of Arnold et al. (U.S. Pat. 5,423,971).

The teachings of Ceasar, Fu and King are discussed above.

As to a target enclosure, Arnold teaches a target enclosure [9], i.e. dark space shield, where the edge of the target enclosure defines the outer edge or perimeter of the area of the target

that is exposed for sputtering. (Fig. 1, col. 3 lines 17-20) The purpose of the target enclosure is to define the plasma zone. (Abstract) Thus, at the time the invention was made, it would have been obvious to one of ordinary skill in the art to further modify Ceasar's invention by employing a target enclosure in order to confine the plasma and prevent parasitic plasmas.

Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar in view of Fu et al. and as evidenced by King as applied to claims 1-3, 9, and 14-16 above, and further in view of Ion Beam Neutralization (Commonwealth Scientific Corporation).

The teachings of Ceasar, Fu and King are discussed above.

As to an end-Hall type of gridless ion source, the Ion Beam Neutralization technical disclosure teaches that an ion source can comprise an end-Hall type of gridless ion source including an electron emitting cathode. (p. 11, applies to claim 10, 11) As to a hollow cathode, the Ion Beam Neutralization technical disclosure teaches that an ion source can comprise a hollow cathode. (pp. 4-5)

At the time the invention was made, it would have been obvious to one of ordinary skill in the art to further modify the invention of Ceasar by employing an end-Hall type of gridless ion source, because the Ion Beam Neutralization technical disclosure teaches that such an ion source has a longer usage lifetime and higher ion-current densities. It would have also been obvious to one of ordinary skill in the art to further modify the invention of Ceasar in view of King and Quazi by employing a hollow cathode, because the Ion Beam Neutralization technical disclosure teaches that such a cathode also has a longer usage lifetime and permits a low ion energy voltage.

*Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Julian A. Mercado whose telephone number is (703) 305-0511. The examiner can normally be reached on Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick J. Ryan, can be reached on (703) 308-2383. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 305-3599 for regular communications and (703) 305-3599 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

jam
September 26, 2002

Patrick Ryan
Supervisory Patent Examiner
Technology Center 1700